Center Innovation Fund: GRC CIF

Thermal History Mapping Technology for Turbine Engine Diagnostics

Completed Technology Project (2017 - 2018)

Project Introduction

The NASA Aeronautic research strategy is to develop and demonstrate revolutionary technologies that enable global air transportation that is safer, more efficient, and more environmentally friendly for the next 30 years and beyond. Increased fuel efficiency is a game changer in gas turbines as fuel is the single most important cost, accounting for up to about 40% of the overall operation cost of commercial aircrafts. Increased fuel efficiency is obtained through increasing the thermal efficiency of the engine by increasing the overall pressure ratio (OPR). Increased OPR requires increased turbine inlet temperature, which is paced by advances in turbine hot section materials temperature capability. High turbine inlet temperature also contributes to environmentally friendly engines by reducing NOx. There are, therefore, ever increasing demands for higher temperature materials and more efficient cooling technologies. The development of high temperature materials and cooling technologies require rigorous rig and engine validation. When gas turbine designers and engineers run the initial tests on new gas turbines, they need to know the temperatures at which the hot section components had operated. Accurate temperature measurements tell the specialists if the engine is functioning within its design limits and whether it might run at a higher temperature and thus efficiency level. CFD analysts need to know accurate thermal map of components to validate CFD analysis. NASA GRC has a critical need for high resolution thermal mapping technology for lifing and CFD analysis of 2700oF EBC-coated cooled CMC components. The fidelity of CFD analysis and lifing depends on the accuracy of the thermal mapping of coated CMC airfoils in combustion rig testing. The project vision is a game-changing thermal sensing technology to enable non-line-of-sight thermal mapping in extreme environments. The goal is to develop a diagnostic tool for non-line-of-sight, non-destructive full-field thermal history mapping of environmental barrier coatings (EBC) for temperatures up to 3000 F (1650 C).

Anticipated Benefits

Knowledge of accurate temperature of space components in extreme environments is needed for component lifing. CFD analysis is used to model the surface temperature. Thermal History Mapping Technology will provide accurate surface temperature data needed to validate CFD model. Potential applications include CFD analysis in space and aero programs and engine test. Knowledge of accurate temperature of space components in extreme environments is also needed for component lifing. Examples of spacecraft components that will benefit from the technology include Ion Thruster in Space electric propulsion engines (e.g. Dawn) and Thermal Protection System (TPS) for Re-entry heat shields

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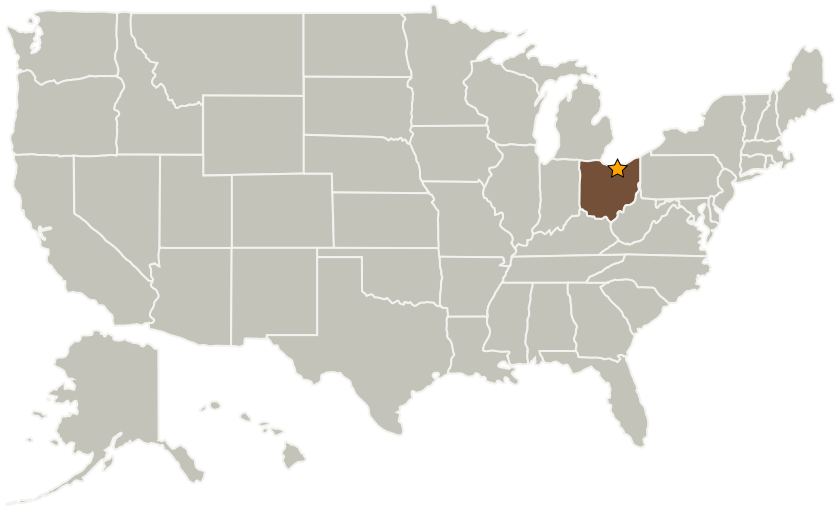
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
Sensor Coating Systems	Supporting Organization	Industry	London, Outside the United States, United Kingdom

Primary U.S. Work Locations
Ohio

Project Transitions

October 2017: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Center Innovation Fund: GRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Managers:

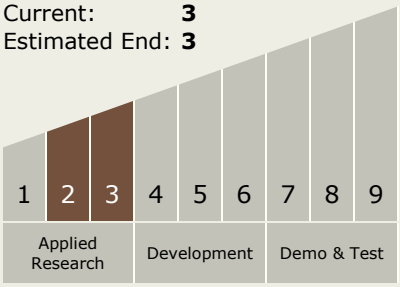
Kurt R Sacksteder
Gary A Horsham

Principal Investigator:

Kang H Lee

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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September 2018: Closed out

Closeout Summary: The project goal is to develop a diagnostic tool for non-lin e-of-sight, non-destructive full-field thermal history mapping of environmental b arrier coatings (EBC) for temperatures up to 3000 F (1650 C). The thermal map ping technology is needed for EBC lifing activities. EBC-coated coupons and com ponents need to be thermally mapped during natural gas burner rig and CE5 co mbustion rig testing to generate EBC performance data at various combustion e nvironments, with one key variable being the temperature. It is also needed to generate validation data for CFD analysis of film cooled EBC-coated CMC airfoil. The current maturity is TRL 3.

Project Website:

https://www.nasa.gov/directorates/spacetech/innovation_fund/index.html#.VC

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.3 Thermal Conditioning for Sensors, Instruments, and High Efficiency Electric Motors

Target Destinations

Earth, Mars, Others Inside the Solar System